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Announcement of Courses
in
Chemistry
and
Chemical Engineering
and of
Graduate Work in Chemistry
for
1937-38

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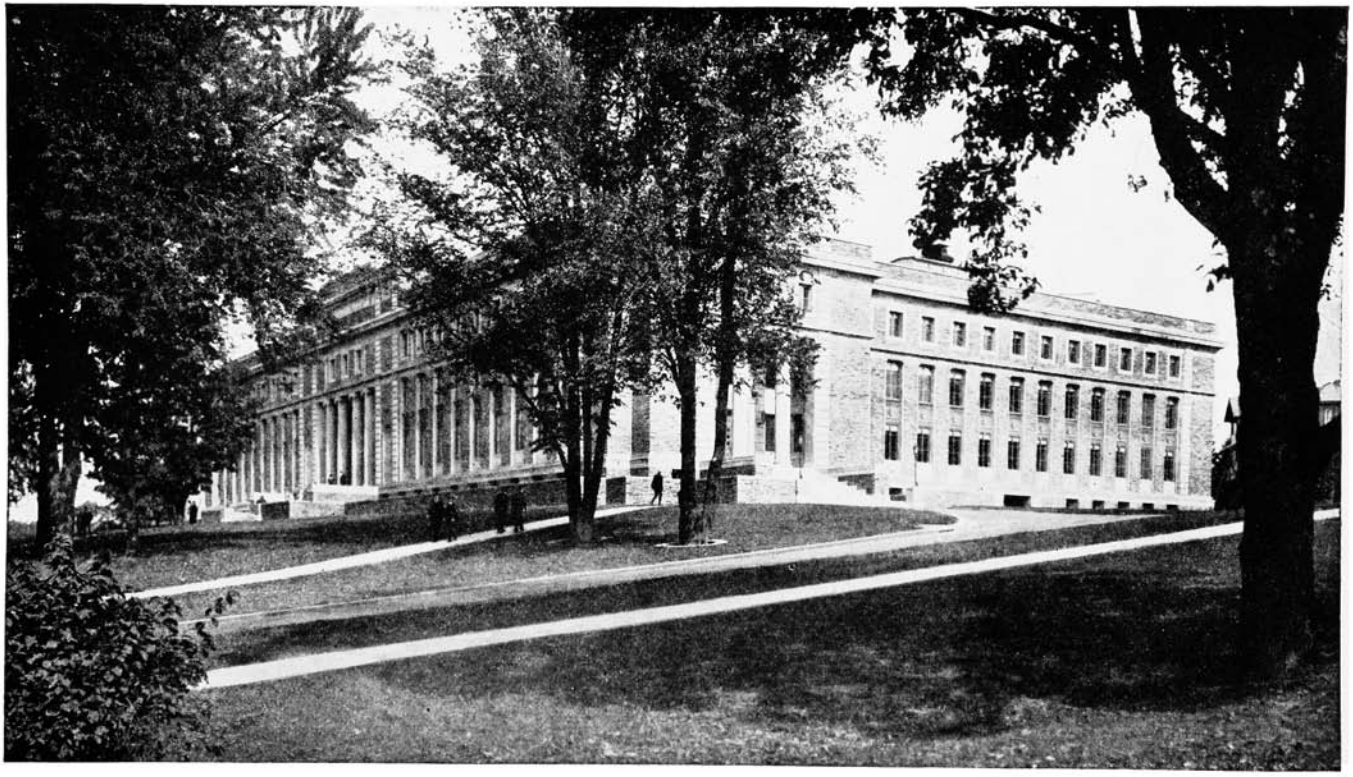

THE BAKER LABORATORY OF CHEMISTRY

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SAUM, ARTHUR MCLEAN, A.B.
SCHEMPF, JOHN MOREY, B.S.
SCHIRMER, FRANK BONNELL, jr., B.S.
SMITH, EARL COPPER, B.S., M.S.
STEVENSON, HALSEY BIDWELL, B. Chem.
VINCENT, ROBERT CORBIN, A.B.
VINCENT, WILLIAM BROWN, A.B.
WHITE, BEN ELWOOD, B.A.

NON-RESIDENT LECTURESHIP

The George Fisher Baker Non-Resident Lectureship in Chemistry at Cornell University was established early in the year 1926 by a gift from Mr. Baker, the income to be used by the University for the benefit and advancement of teaching and research in Chemistry and allied sciences. Under this plan the University invites eminent men of science to come to Cornell to present the most recent advances, and the methods and results of their own investigations, in the fields in which they have won distinction.

The Non-Resident Lecturers under the George Fisher Baker Foundation deliver two lectures a week, and hold a colloquium. In some cases they also conduct experimental research with a few advanced students. The lecturers thus far have been:

Ernst Cohen, Professor of Physical and Inorganic Chemistry, University of Utrecht, Holland. *Second term, 1925–26.*

Fritz Paneth, Professor of Inorganic Chemistry, University of Berlin, Germany. *First term, 1926–27.*

A. V. Hill, Foulerton Research Professor of the Royal Society of London, England. *Second term, 1926–27.*

Paul Walden, Professor of Chemistry, University of Rostock, Germany. *First term, 1927–28.*

George Barger, Professor of Chemistry in its Relations to Medicine, University of Edinburgh, Scotland. *Second term, 1927–28.*

Hans Pringsheim, Professor of Chemistry, University of Berlin, Germany. *First term, 1928–29.*

F. M. Jaeger, Professor of Physical and Inorganic Chemistry, University of Groningen, Holland. *Second term, 1928–29.*

G. P. Thomson, Professor of Natural Philosophy, University of Aberdeen, Scotland. *First term, 1929–30.*

K. Fajans, Professor of Physical Chemistry, University of Munich, Germany. *Second term, 1929–30.*

G. Hevesy, Professor of Physical Chemistry, University of Freiburg in Baden, Germany. *First term, 1930–31.*

N. V. Sidgwick, Fellow and Tutor in Chemistry, Lincoln College, Oxford, England. *Second term, 1930–31.*

C. H. Desch, Professor of Metallurgy, University of Sheffield, England. *First term, 1931–32.*

Alfred Stock, Director of the Chemical Institute, Technische Hochschule, Karlsruhe, Germany. *Second term, 1931–32.*

Otto Hahn, Director of the Kaiser Wilhelm Institut für Chemie, Berlin-Dahlem, Germany. *Second term, 1932–33.*

W. L. Bragg, Professor of Physics, University of Manchester, England. *Second term, 1933–34.*

G. N. Lewis, Professor of Chemistry, University of California. *Summer, 1934.*

J. R. Katz, University of Amsterdam, Holland. *First term, 1934–35.*

Farrington Daniels, Professor of Chemistry, University of Wisconsin. *Second term, 1934–35.*

Ross A. Gortner, Professor of Agricultural Biochemistry, University of Minnesota. *First term, 1935–36.*

W. H. Mills, Lecturer in Organic Chemistry, Cambridge University. *Second term, 1936–37.*

The program of these lectures in 1937–38 is as follows:

FIRST TERM, 1937–38

Professor Linus C. Pauling, California Institute of Technology. Topic: The Nature of the Chemical Bond.

BAKER RESEARCH FELLOWSHIP

The George Fisher Baker Research Fellowship in Chemistry was established in 1935. Under the auspices of this Fellowship young men of recognized ability are afforded the opportunity to pursue independent research work in the Department of Chemistry. Appointments during the year 1936–37 were held by Dr. F. H. Spedding and Dr. H. Neurath.

ASSISTANTSHIPS AND FELLOWSHIPS

A number of Teaching Assistantships (which are really working fellowships) are open to students registered in the Graduate School with major in Chemistry. Applications for these positions should be filed with the Department before March 1.

Assistants receive three-fourths residence credit for graduate work carried on during the period of their appointment. By an additional eight weeks of study in the summer, a full year's residence credit may be earned.

The Sage Fellowship in Chemistry is combined with the Graduate Scholarship in Chemistry, to yield a stipend of $600.

The du Pont Fellowship in Chemistry carries a stipend of $750.

Fellowships are ordinarily awarded to students who have had at least a year of graduate study. Applications for them should be filed before March 15.

THE McMULLEN REGIONAL SCHOLARSHIPS

The McMullen Regional Scholarships in Engineering, of $300 each a year, are awarded to freshmen from states other than New York. Students who intend to pursue the curriculum leading to the degree of Chemical Engineer are eligible for these scholarships, which are described in detail in the Announcement of the College of Engineering.

THE CALDWELL PRIZE

An annual prize of fifty dollars was established by Grace Caldwell Chamberlain and Francis Cary Caldwell in memory of their father, George Chapman Caldwell, Professor in the Department of Chemistry from 1867 to 1902, and Head of the Department until 1902. It is awarded by the Staff of the Department to a member of the Senior class in recognition of general excellence in chemistry. The prize was awarded in 1936 to Gerald Worden Waring. The previous winners were: 1914, A. Bridgman; 1915, F. R. Georgia; 1916, C. G. Stupp; 1917, B. H. Carroll; 1918, M. L. Nichols; 1919, L. H. Clark; 1920, A. C. Wintringham and M. P. Woodward; 1921, H. F. Vieweg; 1922, R. E. Burk; 1923, E. L. Arnold; 1924, T. Parsons, jr.; 1925, H. A. Lovenberg; 1926, R. M. Herbst; 1927, Miss Florence Bush; 1928, M. Benedict; 1929, L. P. Gould; 1930, F. W. Schumacher; 1931, E. G. Rochow; 1932, K. H. Ferber; 1933, G. K. S. Connolly; 1934, no award; 1935, C. C. Nelson.

THE LOVENBERG MEMORIAL PRIZE

An annual prize of fifty dollars was established by Mr. and Mrs. O. F. Lovenberg in memory of their son Harold Adlard Lovenberg, B.Chem., 1925. It is awarded on the basis of an examination held in May, to a member of the senior class in the Course in Chemistry. The examination, set by the Department of Chemistry, is to be of such nature as to test not only the student's general acquaintance with chemistry, but also the breadth and accuracy of his general information.

The prize was awarded in 1936 to William George Huckle.

The previous winners were: E. G. Rochow, 1931; K. H. Ferber, 1932; H. B. Stevenson, 1933; W. B. Johnston, 1934; E. H. Taylor, 1935.

COLLEGE OF ARTS AND SCIENCES

The requirements for entrance to the courses leading to the degree of Bachelor of Arts, Bachelor of Chemistry, or Chemical Engineer, together with information concerning tuition, fees, living expenses, scholarships, prizes, financial assistance, and opportunities for self-support, will be found in the General Information Number, which may be obtained from the Secretary of the University.

REQUIREMENTS FOR THE A.B. DEGREE WITH MAJOR IN CHEMISTRY

COURSES IN CHEMISTRY

*Inorganic Chemistry 101 and 105; or 110 and 115.
*Qualitative Analysis 205 and 206; or 210; or 203.
*Qualitative Analysis 220 and 221; or 225.
Organic Chemistry 305.
Organic Chemistry Laboratory 310 (first term).
Physical Chemistry 405.
Physical Chemistry Laboratory 410 (one term).
Electives in Chemistry, 6 hours.

COURSES IN RELATED SUBJECTS

Mathematics 5a and 5b; Physics 3 and 4 or 7 and 8; German 1 or 1a, or two years of German for entrance.

THE COURSES IN CHEMISTRY

The Department of Chemistry offers a four-year course leading to the degree of Bachelor of Chemistry. Graduates who have completed the required curriculum, or the substantial equivalent thereof, may obtain either the degree of Master of Chemistry or the degree of Chemical Engineer by completing satisfactorily one additional year of study. The additional year of residence required for either of these degrees may, upon recommendation of the student's special committee, be accepted as satisfying one year of the residence requirement for the degree of Doctor of Philosophy. The four-year course leading to the degree of Bachelor of Chemistry is not a prerequisite for the degrees of Master of Arts, Master of Science, or Doctor of Philosophy with major subject in Chemistry.

The elective courses required in the curricula given below may be chosen by the student, in each case with the approval of his adviser, from the advanced courses in Chemistry, or from courses in other departments of the College of Arts and Sciences, or in other colleges of the University.

Students in the Courses in Chemistry may not register for more than 19 hours a term (not including Hygiene) without first securing the consent of the Department.

A student who does not pass at least twelve hours in any term, with a grade of 70 or better in at least six of the twelve hours, may be dropped from the University or placed upon probation. The same penalty may be imposed upon students in the Summer Session, who do not pass four hours, with a grade of 70 or better in at least two hours.

If, in the opinion of the Staff of the Department of Chemistry, a student's general record is unsatisfactory the Staff may recommend that he be refused permission to continue as a candidate for the degree of Bachelor of Chemistry, even though he has passed twelve hours or more in the preceding term. In general, a scholastic record which does not show the completion of at least twelve hours a term of the prescribed studies and a grade of 70 or better in at least half of the hours in Chemistry, will not be considered satisfactory. For admission to the fifth year of work for the degree of Chemical Engineer, a general average of 75 is prerequisite.

Students in the courses in Chemistry who receive a condition may remove it by examination or other requirement set by the Department.

Students who present two or three units of German at entrance will not be required to take the first term of German 1b. Students who present three units of German may, on recommendation of the Department of German, substitute German 8 for the second term of German 1b. The equivalent number of hours of electives will be substituted for the first term of German 1b, in the above cases.

THE DEGREE OF BACHELOR OF CHEMISTRY

The degree of Bachelor of Chemistry will be awarded to those students who have satisfactorily completed either of the following curricula, and the requirements prescribed by the University in Hygiene and Preventive Medicine and in Military Drill or in Physical Training. The completion of Curriculum No. 2, or its substantial equivalent, and an additional fifth year of study is required for the degree of Chemical Engineer (see page 9). Since the first two years of work are identical in the two curricula, the student is afforded ample time to discover whether his interests lie chiefly in the field of pure chemistry or in the field of chemical engineering before he is compelled to decide upon his further course of study.

CURRICULUM NO. 1

First Year

		Course	*First Term*	*Second Term*
Introductory Inorganic Chemistry	Chemistry	110	3	2
Inorganic Chemistry Laboratory	Chemistry	115	3	—
Introductory Qualitative Analysis	Chemistry	203	—	5
Analytic Geometry and Calculus	Mathematics	5a, 5b	5	5
English	English	1	3	3
Introductory Experimental Physics	Physics	11, 12	4	4
			18	19

Second Year

Introductory Organic Chemistry	Chemistry	305	3	3
Organic Chemistry Laboratory	Chemistry	310	3	3
Introductory Quantitative Analysis	Chemistry	220	3	—
Quantitative Analysis Laboratory	Chemistry	221	3	—
Gas and Fuel Analysis	Chemistry	250	—	3
General Physics	Physics	21, 22	3	3
German	German	1b	3	3
Drawing	Engineering	125	—	3
			18	18

Third Year

Introductory Physical Chemistry	Chemistry	405	3	3
Physical Chemistry Laboratory	Chemistry	410	3	3
Advanced Inorganic Chemistry	Chemistry	130	3	3
Introductory Chemical Microscopy	Chemistry	530	—	3
Advanced Quantitative Analysis	Chemistry	230	3	—
Elementary Mineralogy	Geology	311	3	—
Introduction to Economics	Economics	3	—	3
Electives	(at least)		2	2
			17	17

Fourth Year

Unit Operations of Chemical Engineering	Chemistry	705	3	3
Chemical Engineering Laboratory	Chemistry	710	2	2
Special Topics in Physical Chemistry	Chemistry	420	3	—
Special Topics in Chemistry	Chemistry	910	1	—
Electives			8	12
			17	17

The degree of Bachelor of Chemistry, granted upon completion of the four-year course of study just outlined, has a significance that is in some respects unique, and, in so far as a degree may do so, represents a distinctive type of training which its holders have undergone. Although for many years a certain sequence of courses has been required of all students majoring in chemistry, the present degree originated only after careful consideration and trial of its prerequisites. Since 1910, when it was first announced, the course in chemistry has been tested in the classroom as well as by nearly five hundred alumni, and modifications in its curriculum have been made in the light of the development of the science and the demands of industry.

The large majority of Bachelors of Chemistry go into some field of industrial work, and the course in chemistry is planned to give them the training necessary for positions either in the research laboratory or in the plant. This preparation is primarily in the fundamental divisions of chemical science; it moreover includes instruction in special branches designed to acquaint the student with the best modern methods of attacking the various problems that may arise in the future practice of his profession. In the curriculum for this degree, some instruction in engineering subjects is included so that the student may become acquainted with the methods and point of view of the engineer.

COLLEGE OF ENGINEERING

The Degree of Chemical Engineer

Students who intend to complete the curriculum leading to the degree of Chemical Engineer are registered throughout the five years of this course in the College of Engineering, and also in the College of Arts and Sciences.

CURRICULUM NO. 2

First Year		*Course*	*First Term*	*Second Term*
Introductory Inorganic Chemistry	Chemistry	110	3	2
Inorganic Chemistry Laboratory	Chemistry	115	3	—
Introductory Qualitative Analysis	Chemistry	203	—	5
Analytic Geometry and Calculus	Mathematics	5a, 5b	5	5
English	English	1	3	3
Introductory Experimental Physics	Physics	11, 12	4	4
			18	19
Second Year				
Introductory Organic Chemistry	Chemistry	305	3	3
Organic Chemistry Laboratory	Chemistry	310	3	3
Introductory Quantitative Analysis	Chemistry	220	3	—
Quantitative Analysis Laboratory	Chemistry	221	3	—
Gas and Fuel Analysis	Chemistry	250	—	3
General Physics	Physics	21, 22	3	3
German	German	1b	3	3
Drawing	Engineering	125	—	3
			18	18

THIRD YEAR

		Course	First Term	Second Term
Introductory Physical Chemistry	Chemistry	405	3	3
Physical Chemistry Laboratory	Chemistry	410	3	3
Introductory Chemical Microscopy	Chemistry	530	—	3
Elementary Mineralogy	Geology	311	3	—
Mechanics	Engineering	3M21	5	—
Strength of Materials	Engineering	3M22	—	3
Hydraulics	Engineering	3M23	—	2
Materials of Construction	Engineering	3X21	3	—
Materials of Construction	Engineering	3X22	—	3
			17	17

FOURTH YEAR

Unit Operations of Chemical Engineering	Chemistry	705	3	3
Chemical Engineering Laboratory	Chemistry	710	2	2
Advanced Inorganic Chemistry	Chemistry	130	3	3
Advanced Physical Chemistry	Chemistry	420	3	—
Special Topics in Chemistry	Chemistry	910	1	—
Advanced Quantitative Analysis	Chemistry	230	—	3
Heat Power Engineering	Engineering	3P33	3	—
Heat Power Engineering	Engineering	3P34	—	3
Mechanical Laboratory	Engineering	3X33	3	—
Mechanical Laboratory	Engineering	3X32	—	3
			18	17

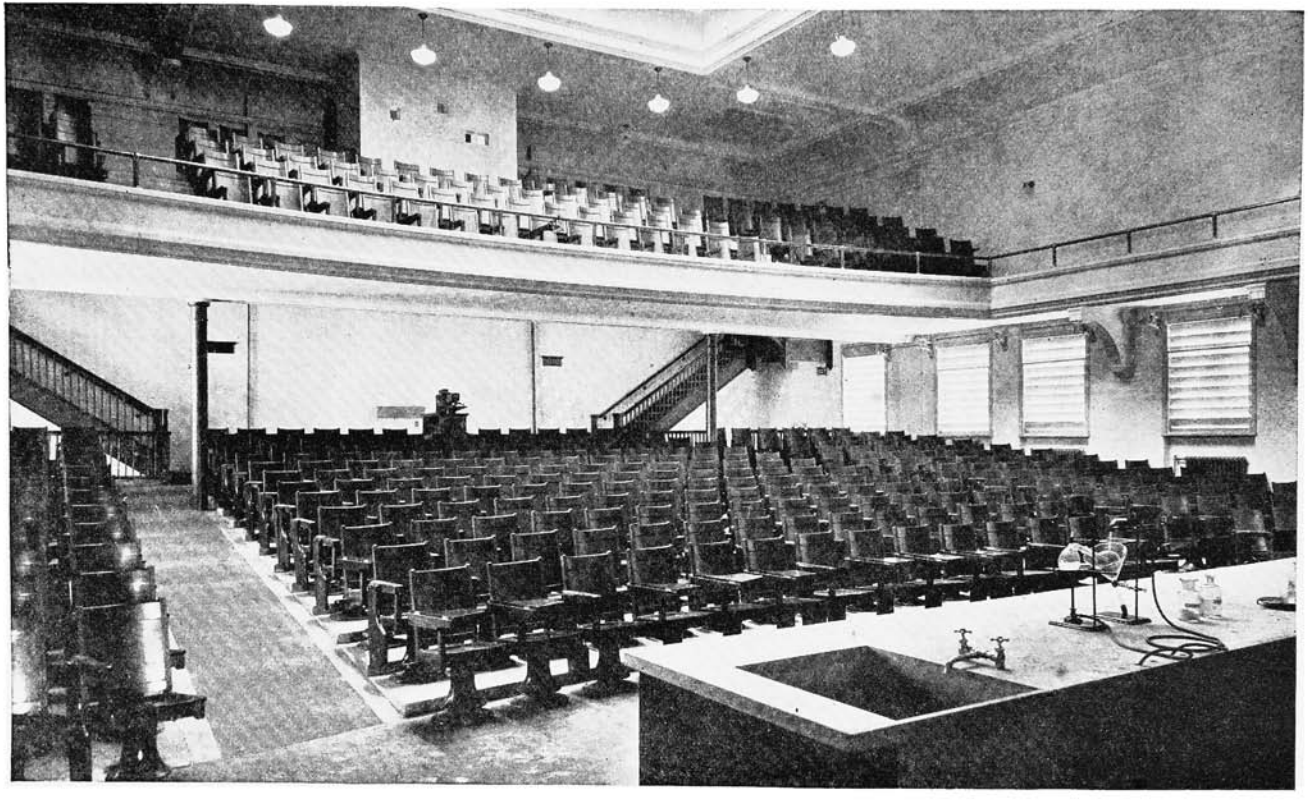
The degree of Bachelor of Chemistry is awarded on completion of the fourth year of this curriculum.

FIFTH YEAR

Students candidates for the fifth year of work leading to the degree of Chemical Engineer will not be allowed to proceed with this fifth year's work unless their general average for the Bachelor's degree is at least 75.

		Course	First Term	Second Term
Electrical Engineering Lectures	Engineering	405	4	—
Electrical Engineering Lectures	Engineering	406	—	4
Machine Design	Engineering	3D34	2	—
Machine Design	Engineering	3D36	1	—
Mechanical Engineering Laboratory	Engineering	3X43	2	—
Industrial Organization	Engineering	3I31	2	—
Chemical Plant Design	Chemistry	730	3	3
Introduction to Economics	Economics	3	—	3
Electives (hours per term variable)			3	7
			17	17

The course of study leading to the degree of Chemical Engineer is intended primarily to prepare the graduate for technical work involving the development and supervision of the operation of industrial chemical processes and plants. It comprises instruction not only in the theoretical principles of chemistry and engineering, but also in the methods of applying these principles to the solution of the problems that arise in the industries.



MAIN LECTURE ROOM

OPPORTUNITIES FOR EMPLOYMENT AFTER GRADUATION

The student's occupation as a chemist after graduation is likely to fall into one of the following classes:

Inspection and control, in industrial, institutional, or government laboratories.

Supervision of operation in chemical plants.

Research and development.

Technical sales or technical purchasing.

Teaching.

A committee on Employment has charge of finding suitable positions in the above fields.

GRADUATE WORK IN CHEMISTRY

In any of the possible careers mentioned above, the scientific and economic position of a chemist is greatly advanced by post-graduate training. In research or plant work the holders of advanced degrees are given preferment, while for teaching positions in institutions of collegiate rank the doctor's degree is usually prerequisite. In order that this degree may have a uniform significance, graduates of other universities are required to present the substantial equivalent of the chemical training included in the Courses in Chemistry, or to complete this during their graduate study at Cornell. Such prerequisite courses should be taken during the first half of the candidate's period of residence, and together with the minor subjects, should give him a sound foundation for the major research problem which will occupy the greater part of his last two years of residence.

REQUIREMENTS FOR GRADUATE STUDY

The Announcement of the Graduate School gives information regarding the general requirements for admission to the Graduate School, and for study toward advanced degrees; the following paragraphs are to be considered as supplementing but in no way superseding these requirements.

Prospective graduate students are strongly advised to communicate, when applying for admission, with a member of the faculty in the division of Chemistry in which they wish to have a major subject.

Entering students must consult the chairman of the Graduate Scholarship Committee of the Department of Chemistry, before registering.

All graduate students in chemistry are required to register at the Record Office of the Department of Chemistry, on the registration days at the beginning of each term of residence, and to file at this office, as well as at the office of the Graduate School, all records of changes in registration, or in major and minor subjects, of completion of language requirements, and of the passing of qualifying or general examinations.

Graduate students are expected to take the examinations in all courses taken in their major and minor fields of Chemistry.

MAJOR IN CHEMISTRY

Entrance Requirements

Candidates for the degree of Master of Arts, Master of Science, or Doctor of Philosophy, with major in Chemistry will be required to offer for admission the equivalent of Introductory Inorganic Chemistry 101 and 105; Qualitative Analysis 205 and 206, or 210; Quantitative Analysis 220 and 221, or 225; Introductory Organic Chemistry 305, and 310 (one term); Introductory Physical Chemistry 405, and 410 (one term); they must also present the equivalent of two units of German.

Candidates for the degree of Master of Chemistry must present the full equivalent of the requirements for the degree of Bachelor of Chemistry at Cornell University.

Minors

For a Master's degree one, and for a Doctor's degree two minor subjects, chosen from different Divisions of the Department, or from other Departments, are required. The candidate is expected to acquire a general knowledge of the fundamental topics (subjects, achievements) in the field of each Minor and an acquaintance with the history of the chief discoveries and generalizations in that field.

The candidate is at liberty to secure this information by lectures, by laboratory courses or by reading, as he may prefer, except that the Member of the Staff in charge of the Minor may require the successful completion of lecture and laboratory courses amounting to not more than six credit hours in all.

If the candidate has acquired the above general knowledge by courses taken before entering upon his graduate work in this Department, he will be assigned advanced reading in the field of the Minor as a means of fulfilling its requirement.

DOCTOR OF PHILOSOPHY

Attention is called to the fact that the additional year of residence required for either the degree of Master of Chemistry or for that of Chemical Engineer at Cornell University may, upon recommendation of the student's special committee, be accepted as satisfying one year of the residence requirement for the degree of Doctor of Philosophy with major subject in Chemistry.

Candidates for the degree of Doctor of Philosophy with major in Chemistry must have completed, before the beginning of the last year of residence, the equivalent of Advanced Quantitative Analysis 230, Introductory Physical Chemistry Laboratory 410 (second term).

Every candidate for the Doctor's degree is required to pass a departmental Qualifying Examination before he is allowed to begin actual experimental work on his thesis problem. This examination will comprise tests in the following four Divisions of Chemistry; (A) Inorganic and General; (B) Analytical; (C) Organic, and (D) Physical. The individual tests, each consisting of a written examination covering a period of two or three hours, will be given in succession at intervals of one week.

One such Qualifying Examination is given at the beginning of each regular term, and at the end of the second regular term of the University year, on days set by the Committee on Qualifying Examinations. The candidate should present himself for the Qualifying Examination not later than the beginning of the term in which he expects to begin actual laboratory work on his thesis problem. In the light of the candidate's achievement in this examination, his Special Committee may further examine his qualifications for graduate study.

Failure of the candidate to pass any one of the four tests with a minimum grade of 60 will entail repetition of that particular test; failure in this second trial, or failure to pass two or more of the tests with a minimum grade of 60 will necessitate repetition of the entire Qualifying Examination. Any candidate who fails to pass all four parts of the Qualifying Examination on this final trial will not be allowed to complete the requirements for the degree of Doctor of Philosophy.

After the candidate has passed the Qualifying Examination, and has completed his minor subjects, he will be required to pass a general examination, both written and oral, on his major and minor subjects. Upon recommendation of the candidate's Special Committee, this examination may be taken toward the end of the term preceding his last year of residence. This procedure makes it possible for the candidate to devote his last year of residence to uninterrupted research on his thesis. At the close of his period of residence, and after the acceptance of his thesis the candidate will be required to pass a final oral examination on the thesis and on related subjects.

As an alternative procedure, the general examination on major and minor subjects and on the thesis may be taken after the acceptance of the thesis.

MINOR IN CHEMISTRY, MAJOR OUTSIDE OF CHEMISTRY

The following courses, or their equivalent, are prerequisite: Introductory Inorganic Chemistry 101 and 105. Qualitative Analysis 210, Quantitative Analysis 225.

The candidate shall have such a knowledge of the minor subject as could be acquired by six credit hours of work in the field.

THE BAKER LABORATORY OF CHEMISTRY

The general equipment of the laboratory and the administration of its various facilities are planned to give the maximum opportunity for unhampered work in the various fields of chemistry. Materials may be subjected to temperatures ranging from those of the electric furnace to that of liquid air, to extreme pressures or high vacua, to electrolysis or to the action of various radiations; they may be studied microscopically, spectroscopically, or by means of x-rays, and the production may be carried out under the exacting conditions of research or in semi-plant scale apparatus. The aim has been to enable chemical behavior to be studied under the widest possible variety of conditions, and by all the different methods used by chemists. On the instructional side, these special methods are available for the demonstration of the whole range of properties of chemical substances, and for the training of students in their observation and interpretation.

The building in which the Department of Chemistry is housed was given to the University by George Fisher Baker. The close co-operation between the Staff of the Department and the architects and engineers engaged in its construction is responsible for scope and facilities hardly surpassed. Some four acres of floor space are available for purposes of instruction, which is given to over 2,000 students every year; the number of registrations in Chemistry courses exceeds 4,000 annually. Exceptionally complete administrative and engineering equipment takes up an additional acre of floor space.

Each of the Divisions of the Department occupies a group of rooms, adjacent to the offices of the instructors in charge, and provided with special plumbing and electric current as required. Distilled water, steam, circulating hot water, cold water, gas and compressed air are supplied to all lecture rooms and laboratories, the last three being supplied to all individual desks. A motor generator set in

LIBRARY STACK ROOM WITH READING ROOM BEYOND

the basement furnishes direct current of constant potential, 55 or 110 volts, by means of a three-wire system, to all the advanced laboratories. A number of these are also connected with a storage battery current for lower voltages. A second motor generator set having a capacity of 2,000 amperes, D.C. or A.C., supplies the heavy currents necessary for electric furnace work, and a special high frequency converter is used in connection with an Ajax-Northrup induction furnace.

The building is ventilated by two separate sets of electrically driven fans which are located in the attic. One set supplies fresh air to all rooms, while the other exhausts air from the hoods in the various laboratories. These hoods are of the open front type, and each is vented to the exhaust flue at the top and bottom of a "baffle-plate" at the back.

The laboratory table tops, sinks, hoods and much of the shelving in the building are of alberene stone.

The main stock rooms are located in the basement, and are connected by elevators with the eight dispensing stock rooms which serve the various laboratories.

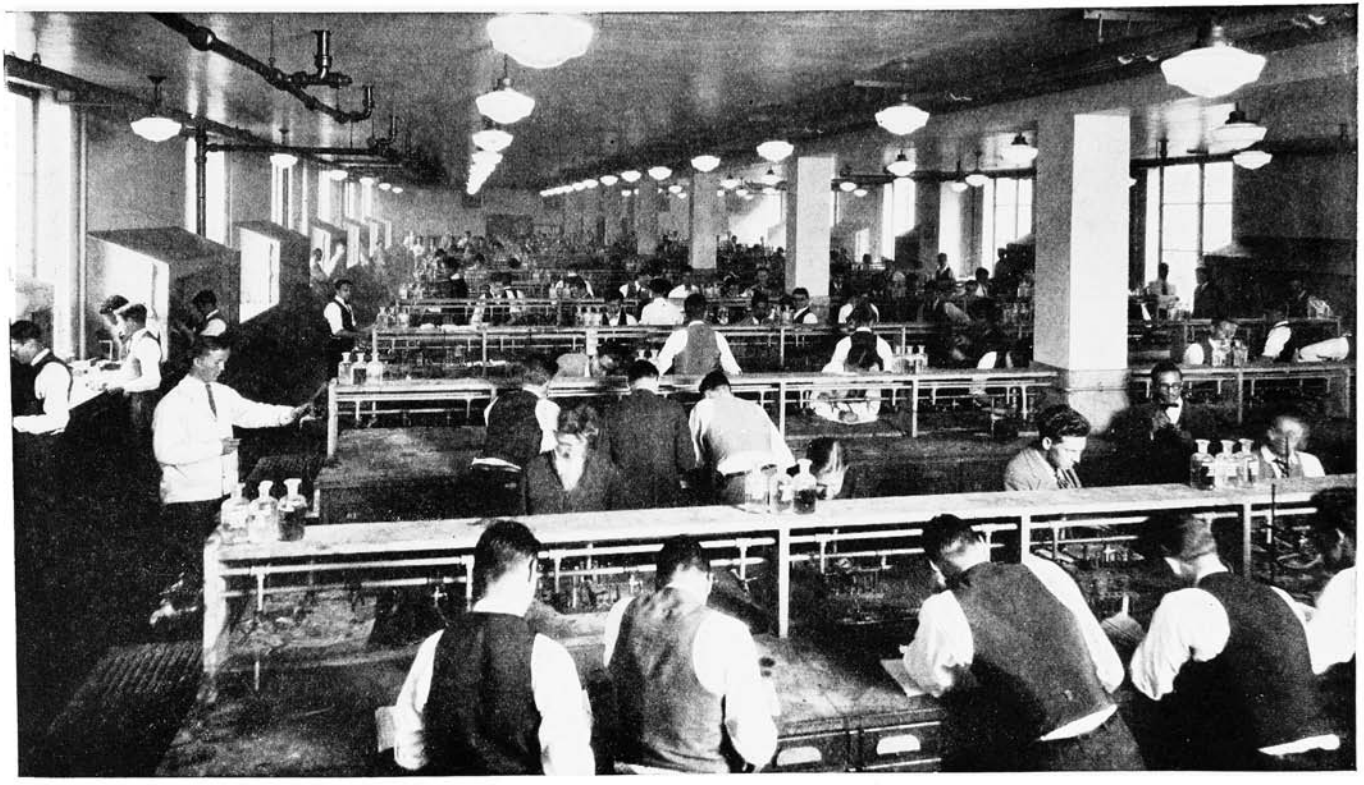
A mechanician, in charge of a completely equipped shop, is available for the construction of special apparatus. An equipment for the production of liquid air, owned jointly with the Department of Physics and housed in the neighboring Laboratory of Physics, Rockefeller Hall, is of such capacity as to furnish an abundant supply of liquid air for lecture demonstrations and investigational purposes.

A locker room with showers, men's and women's rooms, and numerous coat rooms are provided for the convenience of the students and a first aid room is equipped to care for minor accidents.

The main lecture room, seating 476, is so arranged, that all the seats are within 55 feet of the lecture table. It is equipped with rapid-acting shutters, so that it may conveniently be darkened for showing slides or motion pictures. Five other lecture rooms, all containing projection lanterns, communicate through their preparation rooms by electric elevators with the museum. A number of recitation rooms are also provided.

The Museum, through which the main lecture room is reached, is part of the working equipment of the Department and is used as a repository for much of the illustrative material used in the various courses. It contains, in addition to specimens of synthetic and naturally occurring chemical substances, an extensive collection of raw materials and finished products of industries exemplifying the more important commercial chemical processes.

The Department Library is very fully supplied with works of reference and standard books on chemistry and allied subjects, numbering about 9,000 volumes in all. The current numbers of some eighty periodicals are on file in the reading room. In addition the facilities of the library are supplemented by the various other libraries of the University which contain extensive collections of works in other fields of science and engineering. The reading room is open evenings. Advanced students have the privileges of the stack room.



LABORATORY OF INTRODUCTORY INORGANIC CHEMISTRY

COURSES OF INSTRUCTION

CHEMISTRY

All courses listed below are to be given in the Baker Laboratory of Chemistry.

For a major in Chemistry, the following courses must be completed: (1) in Chemistry, courses 101 and 105, 205 and 206, or 210; or preferably 110, 115, and 203; 220 and 221, or 225; 305, 310 (first term); 405, 410 (one term); and six hours of electives; (2) in related subjects, Mathematics 5a and 5b, Physics 3 and 4 or 3 and 6, German 1 or 1a unless two units have been offered for entrance.

Inorganic Chemistry

Students exceptionally well prepared in chemistry should read section 6, P 12 and 13, in regard to College Credit Examination.

Examinations for those who were unavoidably absent from the final examination in Courses 102 and 104 will be held at 2 p. m. on the day before instruction begins in the fall.

*102a. **General Chemistry.** First term. Credit three hours. Open only to students who do not offer entrance chemistry. Deposit, $11.

Professor Browne, Professor Laubengayer, and assistants.

Lecture: M or T 11. *Main Lecture Room, Baker.*

Recitation: one hour a week, to be arranged.

Laboratory: M T W Th or F 1:40–4, or S 8–10:20.

*102b. **General Chemistry.** Second term. Credit three hours. A continuation of Chemistry 102a, which is prerequisite. Hours as for course 102a. Deposit, $11.

*104a. **General Chemistry.** First term. Credit three hours. Prerequisite, entrance credit in chemistry. Deposit, $11. Professor Laubengayer, Dr. Hoard, and assistants.

Lecture: W or Th 11. *Main Lecture Room, Baker.*

Recitation: one hour a week, to be arranged.

Laboratory: M T W Th or F 1:40–4, or S 8–10:20.

*104b. **General Chemistry.** Second term. Credit three hours. A continuation of Chemistry 104a, which is prerequisite. Hours as for course 104a. Deposit, $11.

*106a. **General Chemistry.** First term. Credit three hours. Limited to and required of students of Engineering. Deposit, $11. Professor Laubengayer, Mr. Clagett, and assistants.

One lecture, one recitation, and one laboratory a week, as assigned.

*106b. **General Chemistry.** Second term. Credit three hours. A continuation of Chemistry 106a, which is prerequisite. Deposit, $11.

One lecture, one recitation, and one laboratory a week, as assigned.

*110. **Introductory Inorganic Chemistry.** Throughout the year. Credit three hours first term, two hours second term. Prerequisite, entrance credit in chemistry, or course 101. Required of candidates for the degree of Bachelor of Chemistry, and candidates for the degree of A.B. who intend to major in Chemistry.

Lectures: Professor Laubengayer. First term, T Th S 11; second term, T Th 11. *Baker* 107.

*115. **Introductory Inorganic Chemistry.** Recitations and laboratory practice. First term. Credit three hours. Must be taken with the first term of Chemistry 110. Deposit, $20. Professor Laubengayer and assistants.

Recitations: one hour a week, to be arranged.

Laboratory: W 1:40–4. S 8–10:30. *Baker* 50.

130. **Advanced Inorganic Chemistry.** Throughout the year. Credit three hours a term. Prerequisite or parallel courses, Chemistry 405 and 410. Professor Laubengayer. M W F 11. *Baker* 107.

Lectures. The chemical elements are discussed in the order in which they occur in the Periodic Table of Mendeléeff, with special attention to the group properties of the elements and to the relations of the groups to one another. The rare elements are treated in as great detail as are the more common elements.

135. **Advanced Inorganic Chemistry.** Either term. Credit two to six hours. Prerequisite, Chemistry 305 and 310. Fee variable. Professor BROWNE, Professor LAUBENGAYER, and assistants. Day and hour to be arranged. *Baker* 178 and 122.

Laboratory practice. The preparation, purification, properties, and reactions of inorganic compounds including those of the rarer elements.

Chemistry 135 is designed to accompany Chemistry 130, but either course may be taken separately.

[140. **Selected Topics in Advanced Inorganic Chemistry.** Second term. Credit two hours. Prerequisite, Chemistry 405 and 410, or special permission. Professor BROWNE. W F 9. *Baker* 107. Given in alternate years. Not given in 1937–38.]

[150. **The Chemistry of Glass.** Second term. Credit one hour. Professor LAUBENGAYER. M 9. *Baker* 107. Open to students who have had or are taking course 405; and to others by special permission.

A discussion of the development and manufacture of glass and related ceramic ware, such as pottery and porcelain, with special emphasis on the relations between constitution and physical and chemical properties. Inspection trips to nearby ceramic plants will be arranged. Not given in 1937–38.]

160. **Chemistry of the Rare Elements.** Throughout the year. Credit two hours. Prerequisite, first term of Chemistry 130, or special permission. Professor PAPISH. T Th 9. *Baker* 302.

Lectures. Occurrence, distribution and associations of the rare elements; chemical reactions of the rare elements and of their salts, including analytical reactions.

165. **Chemistry of the Rare Elements.** Throughout the year. Credit two or more hours. Prerequisite or parallel course Chemistry 160. Fee variable. Professor PAPISH and assistant. Hours to be arranged. *Baker* 318.

Laboratory practice. Extraction, recovery and purification of the rare elements, and preparation of their salts. Chemical analysis of the rare elements.

195. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professors BROWNE, PAPISH, and LAUBENGAYER.

ANALYTICAL CHEMISTRY

*201. **Introductory Analytical Chemistry.** Repeated in the second term. Credit four hours. Prerequisite, Chemistry 102 or 104. Deposit, $25. Primarily for students majoring in the biological sciences. Professor NICHOLS and assistants. Lectures: T Th 10. *Baker* 177.

Laboratory sections: W F 1:40–4; S 8–1. *Baker* 252.

A study of the fundamental principles of qualitative and quantitative analysis. Laboratory practice in gravimetric and volumetric quantitative methods.

*203. **Introductory Qualitative Analysis.** Second term. Credit five hours. Prerequisite, one term of Chemistry 110 or special permission. Deposit, $30. Must be taken with the second term of Chemistry 110. Required of candidates for the degree of Bachelor of Chemistry and open to candidates for the degree of A.B. who intend to major in Chemistry. Professor NICHOLS, Dr. LONG, and assistants.

Lecture or recitation: M 9. *Baker* 177. One other recitation, to be arranged.

Laboratory: M W F 1:40–4. *Baker* 50.

*205. **Introductory Qualitative Analysis.** First term only. Credit three hours. Prerequisite, Chemistry 102 or 104. Must be taken with Course 206. Professor NICHOLS, Dr. LONG, and assistants. Lectures: M W 9. *Baker* 177.

Recitations: one hour a week, to be arranged.

A study of the application of the theories of general chemistry to the systematic separation and detection of the common elements and acid radicals.

*206. **Introductory Qualitative Analysis.** First term only. Credit three hours. Prerequisite, Chemistry 102 or 104. Deposit, $25. Must be taken with Course 205. Professor NICHOLS, Dr. LONG, and assistants.

Laboratory section: M W F 1:40–4. *Baker* 50.

Laboratory practice. A study of the properties and reactions of the common elements and acid radicals; the qualitative analysis of a number of solutions and solid compounds.

*210. **Introductory Qualitative Analysis.** Shorter course. Repeated in the second term. Credit three hours. Prerequisite, Chemistry 102 or 104. Deposit, $20. Professor NICHOLS, Dr. LONG, and assistants.

Lecture: T 12. *Baker* 207.

Laboratory sections: T Th 8–10:30; T Th 1:40–4. *Baker* 40.

A study of the properties and reactions of the common elements and acid radicals, and their detection in various solutions.

*220. **Introductory Quantitative Analysis.** Repeated in the second term. Credit three hours. Prerequisite, Chemistry 203, or 205 and 206. Must be taken with Course 221. Professor NICHOLS, Dr. DIEHL, and assistants.

Lectures: T Th 9. *Baker* 207.

Recitations: one hour a week, to be arranged.

A study of the fundamental principles of gravimetric and volumetric analysis with practice in stoichiometry.

Students in science are advised, and candidates for the degree of Bachelor of Chemistry are required, to take this course together with Course 221 instead of Course 225.

*221. **Introductory Quantitative Analysis.** Repeated in the second term. Credit three hours. Prerequisite, Chemistry 203, or 205 and 206. Must be taken with Course 220. Deposit, $20. Professor NICHOLS, Dr. DIEHL, and assistants.

Laboratory sections: F 1:40–4, S 8–1; T Th 10–12:30, Th 1:40–4 (first term only). *Baker* 252.

Laboratory practice in the preparation and standardization of various volumetric solutions and the analysis of a variety of substances by volumetric and gravimetric methods.

Students in science are advised, and candidates for the degree of Bachelor of Chemistry are required, to take this course together with Course 220 instead of Course 225.

*225. **Introductory Quantitative Analysis.** Shorter course. Repeated in the second term. Credit three hours. Prerequisite Chemistry 210. Deposit, $20. Professor NICHOLS, Dr. DIEHL, and assistants.

Lecture: Th 12. *Baker* 207.

Laboratory sections: T Th 8–10:30; M W 1:40–4; T Th 1:40–4. *Baker* 252.

A study of the fundamental principles of gravimetric and volumetric analysis, and the analysis of various substances by these methods.

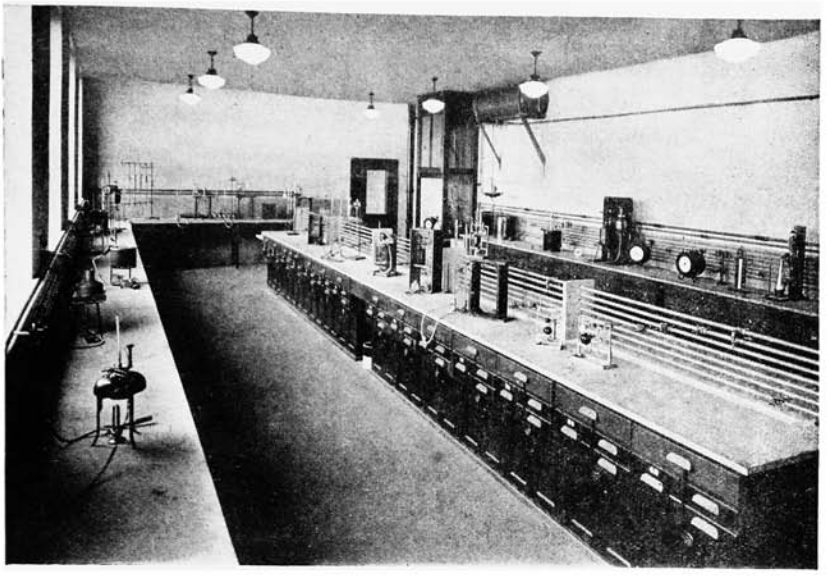
230. **Advanced Quantitative Analysis.** Repeated in the second term. Credit three hours. Prerequisite, Chemistry 220 and 221 or special permission. Deposit, $20. Professor NICHOLS, Dr. DIEHL, and assistants. Recitation: one hour a week, to be arranged. Laboratory periods; first term. T Th 1:40–4; T Th 8–12:30; second term, T Th 1:40–4; T Th 8–12:30; S 8–1. *Baker* 294.

Students will be assigned to a combination of laboratory periods that will total seven and one-half hours a week.

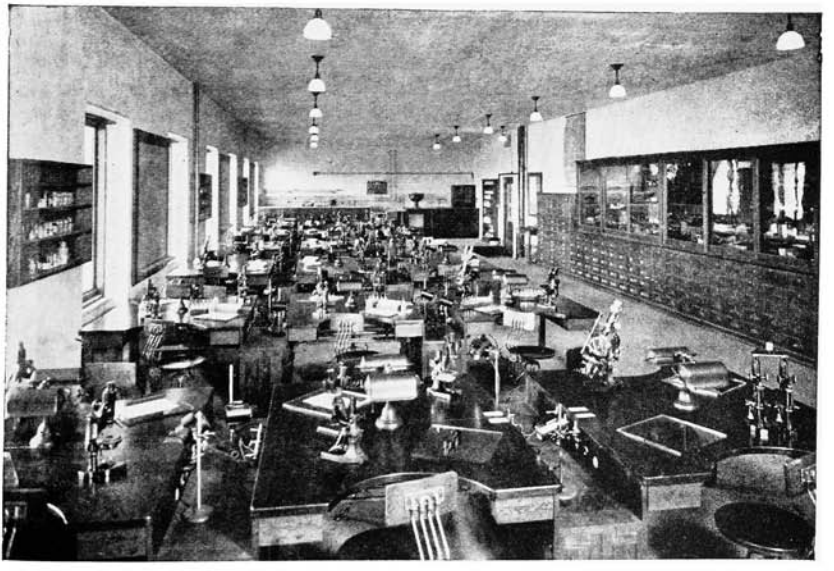
The calibration of weights and volumetric apparatus; the analysis of ferrous and non-ferrous alloys, silicates and organic substances by various gravimetric, volumetric, and combustion methods.

[235. **Advanced Quantitative Analysis.** Second term. Credit two hours. Prerequisite, first term of Chemistry 405. Professor NICHOLS. M W 12. *Baker* 207.

A discussion of selected topics in quantitative analysis, and the development and present status of various analytical methods. Given in alternate years. Not given in 1937–38.]



LABORATORY OF GAS AND FUEL ANALYSIS



LABORATORY OF INTRODUCTORY CHEMICAL MICROSCOPY

250. **Gas and Fuel Analysis.** Second term. Credit three hours. Prerequisite, Chemistry 220 and 221. Fee, $10. Professor NICHOLS and assistants. Lectures: F 10. *Baker* 207.

Laboratory sections: M W 1:40–4; T Th 10–12:30, T Th 1:40–4; S 8–1. *Baker* 282.

The complete analysis of coal gas, flue gas, and air, the determination of the heating power of gaseous, liquid, and solid fuels; the analysis of coal; standard methods of testing various petroleum and coal-tar products; the analysis of various substances by methods involving the use of different types of gas evolution apparatus. Problems are assigned which afford practice in the calculation and interpretation of results.

270. **Special Methods of Quantitative Analysis.** Either term. Credit two or more hours. Prerequisite, Chemistry 230 and 405. Fee variable. Professor NICHOLS, Dr. DIEHL, and assistants. Day and hour to be arranged. *Baker* 277.

Laboratory practice in the application of special methods such as indirect analysis, conductometric and potentiometric titrations, etc., to quantitative analysis and the analysis of special materials. Electrochemical methods for the determination of silver, lead, copper, tin, nickel, cobalt, zinc, iron, etc.; the analysis of alloys and ores. The study of the important methods and special forms of apparatus used in scientific gas analysis.

Within certain limits the work may be selected to suit the requirements of the individual student.

275. **Quantitative Microanalysis.** First term. Credit three or more hours. Prerequisite, Chemistry 230 and special permission. Fee, $20. Professor NICHOLS. Day and hour to be arranged. *Baker* 282.

Laboratory practice in typical methods of both organic and inorganic quantitative microanalysis.

280. **Emission Spectroscopy in Chemical Analysis.** Either term. Credit three hours. Prerequisite, Chemistry 225 or 220, and Physics 21 and 22, or by special permission. Fee, $15. Professor PAPISH and assistant. Laboratory hours to be arranged. *Baker* 396. Conference, hour to be arranged.

The construction and use of spectroscopic equipment; spectrum excitation; qualitative and quantitative spectrochemical analysis.

295. **Research for Seniors.** Throughout the year. Credit two or more hours. a term. Fee variable. Professors NICHOLS and PAPISH, Drs. DIEHL and LONG.

ORGANIC CHEMISTRY

305. **Introductory Organic Chemistry.** Throughout the year. Credit six hours on completion of the course. Prerequisite, qualitative analysis. Open to those who are taking Course 220. Professor JOHNSON and Dr. BRUCE. M W F 9. *Baker* 200.

Lectures and written reviews. The more important compounds of carbon, their occurrence, methods of preparation, relations and uses.

Students who have completed Chemistry 375 may register for Chemistry 305 in the second term and receive two hours credit.

310. **Introductory Organic Chemistry.** Throughout the year. Credit three hours a term. Prerequisite or parallel course, Chemistry 305. Deposit, $35. Professor JOHNSON, Dr. BRUCE, and assistants. Laboratory sections, T Th 10–12:30, Th 1:40–4; F 1:40–4, S 8–1. *Baker* 250.

Laboratory practice and oral reviews. The student prepares a large number of typical compounds of carbon and familiarizes himself with their properties, reactions, and relations.

315. **Advanced Organic Chemistry.** Throughout the year. Prerequisite, Chemistry 305 and 310. Professor JOHNSON, Dr. BRUCE, Dr. MILLER. T Th 9. *Baker* 177.

Lectures. First term, survey of the more important classes of organic compounds and their reactions. Second term, discussion of general topics (tautomer-

ism, molecular rearrangements, stereochemistry). Students may register for either term separately.

320. **Advanced Organic Chemistry.** Either term. Credit two to six hours a term. Prerequisite, Chemistry 305 and 310. Fee variable. Dr. BRUCE and assistants. Day and hour to be arranged. Conference, F 12. *Baker* 206. *Baker* 208.

Laboratory practice. An advanced course in the preparation of organic compounds. The original literature is consulted, and the student is required to repeat some extended and important piece of work, and to compare his results with those published.

325. **Special Topics in Organic Chemistry.** Throughout the year. Credit two hours. Prerequisite, Chemistry 315 or 340, or the consent of the instructor. Professor JOHNSON, Dr. BRUCE, and Dr. MILLER. M W 11. *Baker* 207.

Lectures. A presentation and discussion of special fields and current theories of organic chemistry. For 1937–38 the topics will be: first term, Physical Aspects of Organic Chemistry; second term, Organic Chemistry of Natural Products (Plant and Animal Pigments, Vitamins, Hormones); for 1938–39, first term, Heterocyclic Compounds; second term, Survey of Special Synthetic Methods (including industrial processes).

340. **Identification of Organic Compounds.** Second term. Credit four hours. Prerequisite, Chemistry 305 and 310. Deposit, $20. Dr. BRUCE and assistants. Lectures and conferences, T Th 10. *Baker* 206. Three laboratory periods, M T W or Th 1:40–4. *Baker* 350. With the permission of the instructor, students may register for three hours credit (two laboratory periods.)

The classification reactions of organic compounds and the preparation of solid derivatives are applied to the indentification of unknown organic substances.

375. **Elementary Organic Chemistry.** Either term. Lectures and laboratory, six hours credit. For students in the pre-medical and biological curricula. Prerequisite, inorganic chemistry; qualitative analysis is desirable but not required. Deposit, $20. Dr. BRUCE, Dr. MILLER, and assistants.

Lectures: First term, M W F S 9; second term, M W F S 11. *Baker* 207.

Laboratory Sections: First term, M W 10–12:30; M W 1:40–4; T Th 1:40–4. Second term, M W 1:40–4; T Th 8–10:30. *Baker* 250.

The student should determine the entrance requirement in Organic Chemistry for the particular medical school he wishes to enter. If more than six hours credit is required, he should register in Chemistry 305 and 310. Students may obtain 9 hours credit by taking Chemistry 305 throughout the year (6 hours) and Chemistry 310 (3 hours) during the first term.

By special permission students may register for five hours credit, with only one laboratory period per week: T or Th 8–10:30. Deposit, $15.

395. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professor JOHNSON, Dr. BRUCE, and Dr. MILLER.

Students are advised to complete Chemistry 340 before registering in this course.

PHYSICAL CHEMISTRY

401. **Principles of Physical Chemistry.** Throughout the year. Lectures and laboratory. Primarily for students in the biological sciences. Credit three hours a term. Prerequisite, Chemistry 375 and Physics 3 and 4 or 7 and 8. Deposit, $15. Professor BRIGGS, Mr. ———— and assistants. Lectures: *Baker* 7. T Th 9. Laboratory: M T Th or F 1:40–4. *Baker* 1.

A presentation of the more important principles of physical chemistry, including such topics as the properties of gases, liquids, and solids; physical and chemical equilibrium; osmotic pressure, vapor pressure, and the elementary theory of solutions; ionization and ionic equilibria in solutions; electrolysis; chemical kinetics and catalysis; and colloid chemistry.

405. **Introductory Physical Chemistry.** Throughout the year. Credit three hours a term. Prerequisite, Chemistry 305, Mathematics 5a and 5b and Physics 11 and 12 (or their substantial equivalent). Professor BRIGGS and assistants. Lectures, M W F 9. *Baker* 7.

A systematic presentation of modern physical chemistry. The topics include: the properties of gases, liquids, and solids; physical and chemical equilibrium in homogeneous and heterogeneous systems; the Mass Law, theorem of Le Chatelier, and the Phase Rule; thermochemistry and elementary thermodynamics; the theory of solutions; ionic equilibria and the concept of activity; chemical kinetics and catalysis; photochemistry; written problems in physical chemistry.

410. **Introductory Physical Chemistry.** Throughout the year. Laboratory and recitations. Credit three hours a term. Prerequisite or parallel course, Chemistry 405. Deposit, $20. Professor BRIGGS, Mr. ————, and assistants. Laboratory sections: M T 1:40–4; Th F 1:40–4; and S 8–1. *Baker* 1. Recitations to be arranged.

Qualitative and quantitative experiments illustrating the principles of physical chemistry and practice in performing typical physico-chemical measurements. Recitations on the general principles of physical chemistry, based upon the lectures given in Course 405.

420. **Advanced Physical Chemistry.** First term. Credit three hours. Prerequisite, Chemistry 405. Required of candidates for the degree of Bachelor of Chemistry. Dr. HOARD. Lectures and recitations, M W F 12. *Baker* 7.

Exposition of the principles of physical chemistry from the mathematical standpoint, with emphasis on the solution of simple problems.

[425. **Applications of the Phase Rule.** First term. Credit two hours. Prerequisite, Chemistry 405. Professor BRIGGS. Lectures: M W 11. *Baker* 7.

The study and interpretation of typical phase diagrams in systems of one, two, three and four components. Special attention will be paid to equilibria in saturated salt solutions and to the problem of indirect analysis. Given in alternate years. Not given in 1937–38.]

430. **Colloid Chemistry.** First term. Credit two hours. Open to candidates for the degree of Bachelor of Chemistry if they have completed Chemistry 405, to others only by special permission. Professor BRIGGS. T Th 10. *Baker* 7.

Lectures. The theory of colloid chemistry and its application in the arts.

[435. **Chemistry of Solids.** First term. Credit three hours. Prerequisite or parallel courses, Chemistry 405, and 530 or 545 or special permission. Hours to be arranged. Professor MASON and Dr. HOARD. *Baker* ————.

A general discussion of the formation and growth of metallic and chemical crystals, their physical and chemical behavior, and the relationships between lattice structure and chemical constitution. Given in alternate years, not given in 1937–38.]

445. **Introductory Electrochemistry.** Second term. Lectures, informal recitations, and laboratory. Credit three hours. Prerequisite, Chemistry 405. Deposit, $15. Professor BRIGGS and assistants. Lectures: M W 12. *Baker* 7. Laboratory: T W Th or F 1:40–4. *Baker* 1A.

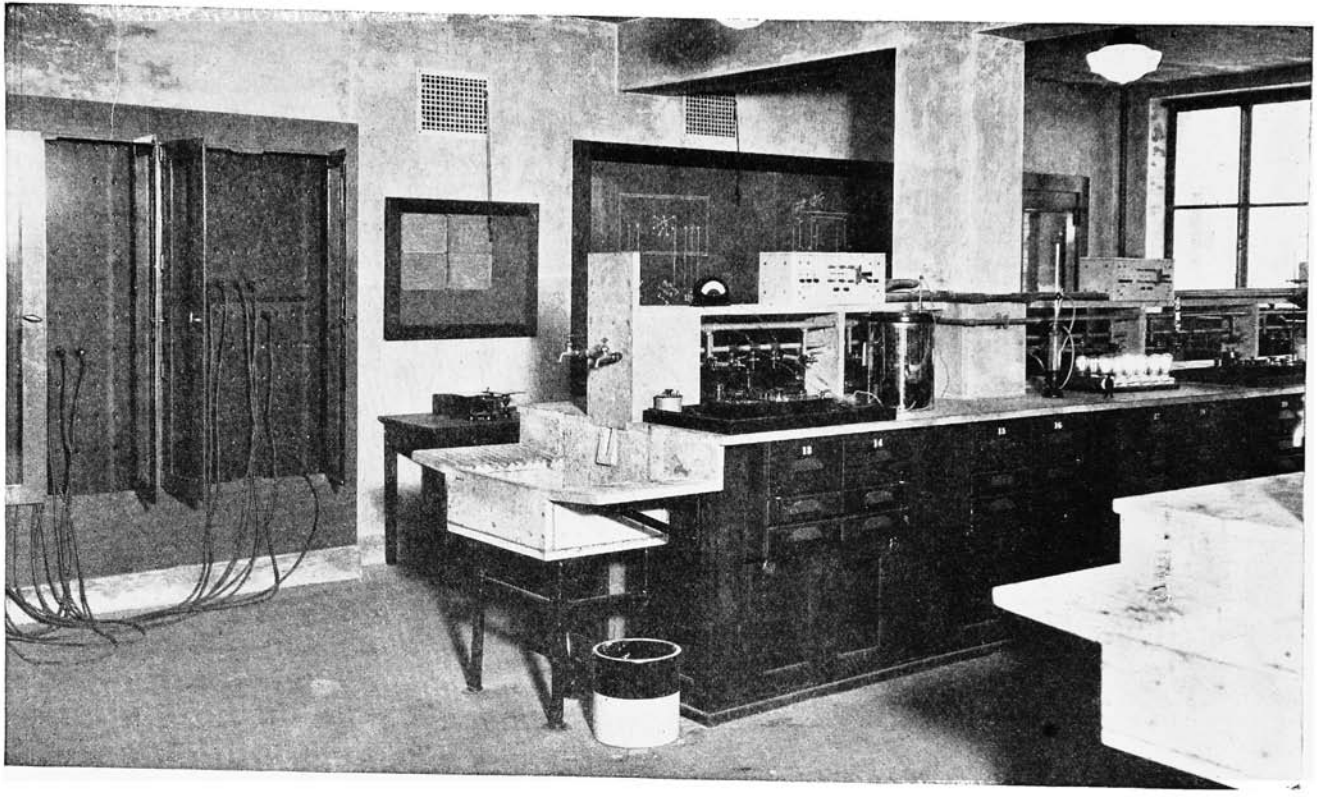
Theory of electrolysis and the voltaic cell, including the theory and practice of determining transference numbers, the activities of ions, oxidation-reduction potentials, solubility by electrometric methods, and similar subjects.

[450. **Applied Electrochemistry.** First term. Credit two hours. Prerequisite, Chemistry 445. Professor BRIGGS. M W 11. *Baker* 7.

Lectures. The electrolytic refining and extraction of metals; the electrolytic manufacture of organic and inorganic compounds; the theory and practice of storage cells, the electric furnace. Given in alternate years. Not given in 1937–38.]

By taking Course 465 (2 or more hours), the student may supplement this course with laboratory practice dealing with the various topics presented in the lectures. The experiments include the measurement and study of decomposition voltages; current and energy efficiencies in electrolysis; the deposition of metals; the preparation of chemical compounds by electrolysis; and the testing of storage cells.

465. **Advanced Laboratory Practice in Physical Chemistry.** Either term. Credit variable, but not to exceed six hours a term. Prerequisite, determined in



LABORATORY OF ELECTROCHEMISTRY

each case by the Professor in charge. Fee variable. Professor BRIGGS, Professor KIRKWOOD, and assistants. Hour and place to be arranged.

[470. **Thermodynamics.** Throughout the year. Credit three hours a term. Prerequisite, Chemistry 405 and 420, or special permission. M W F 9. *Baker* 18.

Development of the general equations of thermodynamics from the first and second laws. Exposition of the concepts of entropy and free energy. Applications to the study of physico-chemical equilibria in gases, liquids, solids, and liquid solutions. Problems. Not given 1937–38.]

[480. **Statistical Mechanics.** Second term. Credit three hours. Prerequisite, first term Chemistry 470. M W F 12. *Baker* 18.

Exposition of the equilibrium theory of statistical mechanics from the standpoint of the Gibbs canonical ensemble. Mechanical interpretation of the principles of thermodynamics, with application to simple thermodynamic systems. Given in alternate years. Not given in 1937–38.]

[490. **Introductory Quantum Mechanics with Chemical Applications.** Second term. Credit three hours. Open to qualified students by permission. Hours to be arranged.

Elementary presentation of the principles of quantum mechanics. The basic ideas underlying the quantum mechanical theory of the chemical bond. Given in alternate years. Not given 1937–38.]

495. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professor BRIGGS and Dr. HOARD.

CHEMICAL MICROSCOPY AND METALLOGRAPHY

530. **Introductory Chemical Microscopy.** Repeated in the second term. Credit three hours. Prerequisite, or parallel courses, Chemistry 405 and Physics 21 and 22, or special permission. Fee, $5. Professor MASON and assistants.

Lecture: M 10. *Baker* 377.

Laboratory sections: M T 1:40–4; T Th 9–11:30. *Baker* 378.

Lectures and laboratory practice. The use of microscopes and their accessories in chemical and technical investigations. Micrometry; quantitative estimations; microscopical characteristics and physical chemistry of crystals; illumination, ultra-microscopy and photomicrography; study of industrial materials such as textile and paper fibers.

Graduate students are advised to take this course the first term.

535. **Microscopic Qualitative Analysis (Inorganic).** Either term. Credit two or more hours. Prerequisite, Chemistry 530. Fee, $5. Professor MASON and assistants. Laboratory periods, to be arranged. *Baker* 378.

Laboratory practice in the examination and analysis of inorganic substances containing the more common elements with special reference to rapid qualitative methods and to the analysis of minute amounts of material.

540. **Microscopical Methods in Organic Chemistry.** Second term. Credit two or more hours. Prerequisite, Chemistry 530, and special permission. Fee, $5. Professor MASON and assistants. Day and hour to be arranged. *Baker* 378.

Laboratory practice. General manipulative methods applicable to small amounts of material, crystallization procedures, determination of melting points and molecular weights; chemical tests and reactions for elements, radicals, and various types of organic compounds. Preparation of simple derivatives.

545. **Introductory Metallography.** First term. Credit three hours. Prerequisite or parallel course, Chemistry 405, or Engineering 3X31. Fee, $10. Professor MASON and assistant. Th F 1:40–4; additional M T 1:40–4 section if warranted. *Baker* 384. Conference or lecture, Th 10.

Laboratory practice, conferences and reports. An introduction to the principles and methods involved in the study of the structure of metals. The relation of microscopical appearances to thermal history and mechanical properties. Preparation of specimens for macroscopic and microscopic study. Metallographic microscopes and their use.

550. **Advanced Metallography.** Second term. Credit variable. Prerequisite, Chemistry 545, and consent of the instructor. Fee variable. Professor MASON. Hours to be arranged. *Baker* 384.

Laboratory practice and reports. The work may be selected in accordance with the interests of the student, from topics such as heat treatment and structures of various ferrous or non-ferrous alloys, special methods of polishing, etching, and photomicrography, or minor research problems.

565. **Special Methods in Chemical Microscopy.** Either term. Credit one or more hours. Prerequisite, special permission. Fee variable. Professor MASON. Day and hour to be arranged. *Baker* 378 and 382.

Laboratory practice may be elected in various fields such as photomicrography, ultra-microscopy, crystal studies, micro-manipulations, quantitative determinations, and the microscopy of industrial materials such as pigments, textiles, papers, and foods.

595. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professor MASON.

CHEMICAL ENGINEERING AND INDUSTRIAL CHEMISTRY

705. **Unit Operations of Chemical Engineering.** Throughout the year. Credit three hours a term. Prerequisite, Chemistry 405. Professor RHODES. W M F 10. *Baker* 177.

Lectures. A critical discussion of the important unit operations of chemical engineering: fluid flow, heat transfer, evaporation, distillation, filtration, gas absorption, crushing and grinding, etc. In these lectures, particular emphasis is placed on the fundamental theory upon which the various unit operations are based.

710. **Unit Operations Laboratory.** Throughout the year. Credit two hours a term. Prerequisite, Chemistry 405. Fee, $10. Professor RHODES, Dr. WINDING and assistants. Laboratory period, day and hour to be arranged. *Baker* B-78. Conference period, Th 11. *Baker* 207.

The study in the laboratory, on a semi-plant scale, of the unit operations of chemical engineering, such as agitation, and mixing, filtration, fractional distillation, evaporation, drying, absorption of gases, and heat transfer.

715. **Unit Processes of Chemical Engineering.** Second term. Credit three hours. Prerequisite or parallel course, Chemistry 705. Professor RHODES. M W F 11. *Baker* 177.

Lectures. A discussion of the important typical unit processes of chemical engineering; as, for example, nitration, sulphonation, esterification, caustic fusion, chlorination, etc.

725. **The Chemistry of Fuels.** First term. Credit three hours. Prerequisite or parallel course, Chemistry 705. Professor RHODES. M W F 11. *Baker* 177.

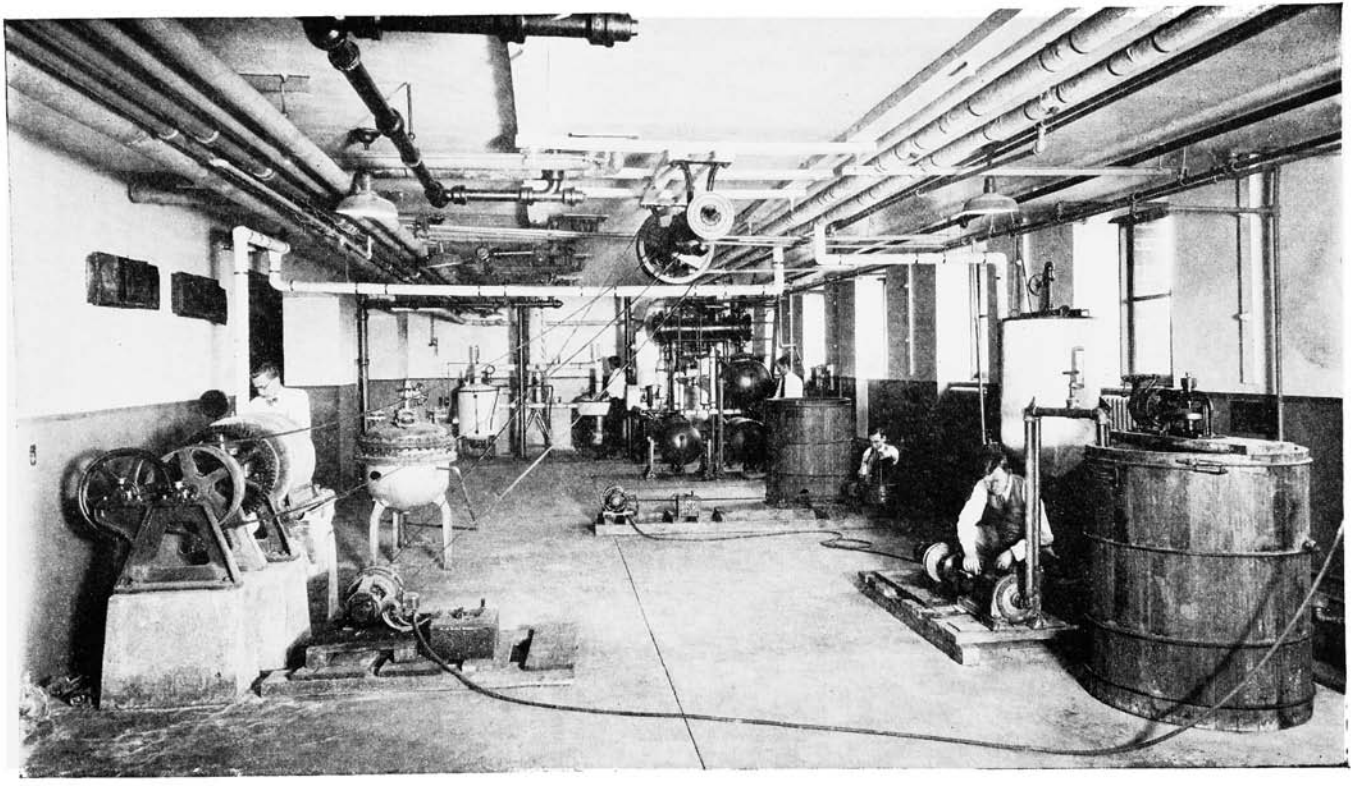
Lectures. The chemistry of coal, coke, petroleum tars, and the fuel gases. Particular stress is laid upon the theoretical chemistry involved in the carbonization of coal, the gasification of coal, and the distillation and refining of petroleum and tar.

730. **Chemical Plant Design.** Throughout the year. Credit three hours a term. Prerequisite, Chemistry 705. Deposit, $10. Professor RHODES. Day and hour to be arranged.

One conference and two laboratory periods. Practice in the calculation and design of chemical plant equipment.

735. **Plant Inspections.** Second term. Credit one hour. Prerequisite or parallel course Chemistry 705.

Visits to plants typical of various chemical industries. Conferences and reports. A trip during spring vacation will be a feature of this course. Fee, covering expenses, to be announced.



LABORATORY OF CHEMICAL ENGINEERING

740. **Chemical Engineering Computations.** Throughout the year. Credit two hours. Prerequisite or parallel course, Chemistry 705. Dr. WINDING. Hours to be arranged.

Conferences and lectures. Problems in stoichiometric relationships, material balances and reaction rates, fluid flow and heat transfer, distillation, evaporation and drying, humidification and air conditioning, and filtration.

750. **Furnace Metallurgy.** Second term. Credit two hours. Prerequisite or parallel course, Chemistry 405. Professor RHODES. T Th 10. *Baker* 377.

Lectures. A discussion of the reactions involved in the smelting of ores and the furnace refining of metals. The discussion is accompanied by problems dealing with the various subjects discussed.

795. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professor RHODES and Dr. WINDING.

AGRICULTURAL CHEMISTRY

Students will not be allowed to register in courses in Agricultural Chemistry until after they have taken and passed Chemistry 102 or 104, or their equivalent.

805. **Introductory Agricultural Chemistry (Fertilizers, Insecticides, Soils).** First term. Credit two hours. Prerequisite, Chemistry 305 (or 375). Professor CAVANAUGH. T Th 11. *Baker* 302.

Lectures. The relation of chemistry to agriculture; an introduction to the study of plant growth, the composition and chemical properties of soils, fertilizers, amendments, insecticides, and fungicides.

810. **Introductory Agricultural Chemistry.** First term. Credit three hours. Prerequisite, Chemistry 205 and 220 (or 210 and 225). Fee variable. Professor CAVANAUGH and assistant. *Baker* 350.

Laboratory practice: day and hour to be arranged. Recitation: day and hour to be arranged. Practice in the methods used by the chemist in the control laboratories of the factory, of the Government, and of the Experiment Stations, where fertilizers, insecticides, fungicides, and soils are examined.

815. **Introductory Agricultural Chemistry (Foods and Feeds).** Second term. Credit two hours. Prerequisite, Chemistry 305 (or 375). Professor CAVANAUGH. T Th 11. *Baker* 302.

Lectures. Discussion of the sources, chemical composition, and properties of the principal foods and feeds such as cereals, fruits, animal products, and dairy products. Relation of methods of preservation and manufacture to the nutritive value of foods.

820. **Introductory Agricultural Chemistry (Food Analysis).** Second term. Credit three hours. Prerequisite, Chemistry 205 and 220 (or 210 and 225). Fee variable. Professor CAVANAUGH and assistant. *Baker* 350.

Laboratory practice T Th 1:40–4, or W F 1:40–4. Recitation: day and hour to be arranged. The methods of the Association of Official Agricultural Chemists are used in the examination and analysis of foods and feeding stuffs, such as milk and milk products, cereal products, canned vegetables, etc.

*825. **Elementary Agricultural Chemistry.** Second term. Credit three hours. Prerequisite, Chemistry 102. Professor CAVANAUGH. M W F 12. *Baker* 377. Candidates for the degree of Bachelor of Chemistry may not receive credit for this course toward the degree.

Lectures. The relation of chemistry to agriculture, and an introduction to the study of the composition and chemical properties of plants, fertilizers, feed stuffs, insecticides, and fungicides.

*830. **Elementary Chemistry of Food Products.** Second term. Credit two hours. Prerequisite, Chemistry 102 or 104. Professor CAVANAUGH. W F 10. *Baker* 377. Candidates for the degree of Bachelor of Chemistry may not receive credit for this course toward the degree.

Lectures. The chemical composition, physical and physiological properties, sources, and methods of manufacture of the principal food products.

835. **Advanced Agricultural Chemistry (Fertilizers, Insecticides, Soils).** Either term. Credit two or more hours. Prerequisite, Chemistry 810. Fee variable. Professor CAVANAUGH and assistant. Day and hour to be arranged. *Baker* 350.

Laboratory practice. Advanced work in the chemistry of soils, fertilizers, plant composition, insecticides, or fungicides. Special topics may be selected.

840. **Advanced Agricultural Chemistry (Foods and Feeds).** Second term. Credit two or more hours. Prerequisite, Chemistry 820. Fee variable. Professor CAVANAUGH. Day and hour to be arranged. *Baker* 350.

Laboratory practice. Special topics in the chemistry of foods and food preparations.

895. **Research for Seniors.** Throughout the year. Credit two or more hours a term. Fee variable. Professor CAVANAUGH.

SPECIAL TOPICS

910. **Special Topics in Chemistry.** First term. Credit one hour. Required of candidates for the degree of Bachelor of Chemistry. Professors RHODES and MASON. T 11. *Baker* 207.

The use of chemical literature; methods of research; administration of chemical laboratories; patent law; and other special topics.

Graduate students are advised to take this course before beginning thesis work.

1000. **Non-Resident Lectures on the George Fisher Baker Foundation.** Credit two hours. T Th 12. *Baker* 177. Open to seniors in the course in Chemistry, and to juniors on special permission.

First term: The Nature of the Chemical Bond. Professor LINUS C. PAULING, California Institute of Technology.

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